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ABSTRACT

This paper examines and critiques several learning style inventories (LSI) in an effort to find the optimal research instrument for a proposed empirical study of both the quality of courseware and the impact of courseware characteristics on variations of learning effectiveness due to learner characteristics. Five LSIs are examined: (1) Dunn LSI; (2) Entwistle's styles of learning; (3) Hunt's conceptual levels; (4) Kolb's LSI; and (5) two preference scales for students, the Grasha-Riechmann Student Learning Style Scales and Owens and Straton's Learning Preference Style for Students. The strengths and shortcomings of each model or instrument are detailed, reasons for choosing the Kolb LSI as the study instrument are given, and a brief outline of the proposed empirical study is provided. The text is supplemented by one figure and three tables. (15 references, 13 in English and 2 in German) (Author/EW)

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COMPARISON OF LEARNING STYLE INVENTORIES (LSI)

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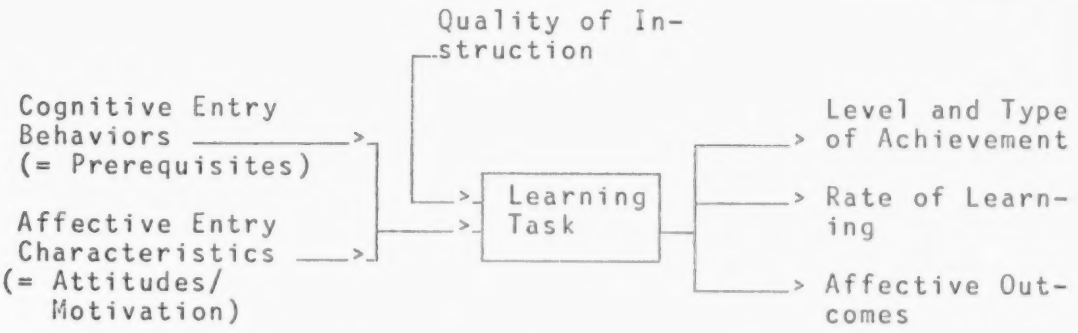
1. Introduction

An empiric study will be the next step within a dissertation project after having conducted literature reviews, two surveys, and an explorative trip to the U.S.A. focusing on quality courseware development.

The context of the empiric study
Impacts of courseware characteristics (different **content, strategies,** implementation of **instructional factors**) on variation(s) of learning effectiveness (cognitive and affective) due to **learner characteristics** shall be put forward for examination. This research question can be illustrated applying Bloom's theory of school learning as follows[1]:

Student Characteristics	Instruction	Learning Outcomes
= given Parameters	= Independent Variable(s)	= Dependent Variable(s)



Students characteristics are split up in cognitive and affective entry behaviors. The first include the knowledge base or cognitive history of (a) learner(s), verbal ability, reading comprehension, written presentation, study style, and the general intelligence. The latter encompass the affective history of (a) learner(s), interests, motivation, attitudes, self-concept and personality mood anxiety.

A **learning task** may be described as a learning unit in a course, a chapter in a textbook, or a topic in a course or curriculum. This unit contains a variety of ideas, procedures, or behaviors to be learned over a relatively short period of time.[2] The **quality of instruction** can be seen as aspects and/or characteristics having impacts on the interaction between instruction and students.

Finally, **learning outcomes** have to be considered alongside entry predispositions.

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[1] For further details see: B.S. Bloom, Human Characteristics and School Learning, New York, 1982, and: U. Karrer, Design of the Empiric Study, Seon, Dec. 1987 (unpublished material)

[2] B.S. Bloom, 1982, p. 22

This paper will focus on the learning style as a (cognitive) student entry behavior and its identification for the purpose of the empiric study.

Definition of terms

Learning styles are not conceived as fixed personality traits but as possibility processing structures resulting from unique individual programming of the basic but flexible structure of human learning.[3] To conclude, learning styles are cognitive, affective, and physiological traits that serve as relatively stable INDICATORS of how learners perceive, interact with, and respond to the learning environment.[4]
(Cognitive) styles are a theoretical concept that helps to explain the learning and teaching process. Most styles are bipolar, representing a continuum from one extreme of a trait to the other.

Evolution of learning style inventories[5]

Elements of learning style approaches appeared in the literature as early as 1892, but the findings were plagued with methodological flaws and with determining the one perceptual mode that would best improve student learning. Specific research on cognitive styles was expanded in the U.S.A. after 1945 (e.g. at Brooklyn College, the Menninger Foundation, and the Fels Institute). Current efforts to explain the underlying processes of learning and teaching reflect two directions: One group retains strong interest in the cognitive dimensions of learning style. The other direction focuses on applied models of learning and teaching and multidimensional analysis of styles.

Assumptions

Instructors (and researchers) working with the paradigm and instruments of "learning styles" have to be aware of some underlying (important) assumptions as follows:[6]

1) Everybody develops his/her own learning style.
2) It is possible to identify a person's learning style.[7]
3) A student can identify his/her (actual) learning style through a learning style inventory.
4) Moreover, it is possible to create an appropriate learning environment coping with all learning styles to guarantee enhanced learning effectiveness.

Remainder

This paper will give an overview of selected instruments and models to describe and identify (cognitive) learning styles. Moreover, strengths and shortcomings of such learning style in-

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[3] D.A. Kolb, Experiential learning, Englewood Cliffs, 1984, p. 96 - 97

[4] J.W. Keefe, Assessing Student Learning Styles: An Overview, in: NASS Principals (Eds.), Student Learning Styles and Brain Behavior, Reston (VA), 1982, p. 44

[5] J.W. Keefe, 1982, p. 44

[6] See: R. Dubs, Kleine Unterrichtslehre für den Lernbereich Wirtschaft, Recht, Staat and Gesellschaft, Aarau, Frankfurt a. M., Salzburg, 1985, pp. 122 - 123

[7] However, it is not obvious whether a learning style is an ever lasting personality trait or changing over time (see Keefe's definition above).

ventories (LSIs) will be outlined. Comparing the research question with discussed learning style instruments, a selection of an appropriate instrument for the planned empiric study will be made.

2. Rough description of selected instruments and models to identify learning styles

This chapter introduces (in alphabetic sequence) a selection of learning style inventories (LSI) and models: Dunn LSI, Entwistle's styles of learning, Hunt's conceptual levels, Kolb's LSI, and the concept of preference scales (e.g. the SLSS) for students.

2.1. Dunn LSI[8]

The instrument encompasses 104-item true-false statements. The Dunns and Price define "learning style" in terms of four pervasive learning conditions and 18 elements. These learning conditions (and/or stimuli) are:

- immediate **environment** (with the elements sound, light, temperature, and design);
- own **emotionality** (with the elements motivation, persistence, responsibility, and structure);
- **sociological** needs (with the elements self-oriented, colleague-oriented, authority-oriented, pair-oriented, team-oriented, and varied), and
- **physical** requirements (with the elements perceptual, intake, time, and mobility).

A child specific learning style profile is obtained for which a learning environment conducive to that learning style may be constructed. Computerized scoring is available with individual and group profiles. Printouts indicate learning preferences on 36 subscales. The Dunn LSI was designed for upper elementary children, but is currently being used with high school and college students, too. It is the most widely used assessment instrument in elementary and secondary schools.[9]

2.2. Entwistle's styles of learning[10]

In series of studies, Entwistle developed a **model of learning behavior** together with an inventory. **Five learning styles** resulting from empiric studies have been worked out. The learning process is divided into two phases. Entwistle distinguishes **four basic learning processes**. Effective learning and

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[8] K. Dunn, R. Dunn, Teaching Students Through their Individual Learning Styles: A Practical Approach, Reston (VA) [Publishing Company, Inc.], 1978

[9] J.W. Keefe, 1982, p. 52

[10] See: N. Entwistle, M. Hanley, and D. Hounsell, Identifying Distinctive Approaches to Studying, in: Higher Education, Vol. 8 (1979), No. 1 (January), pp. 365 - 380

a deep level of comprehension is only possible if all four learning processes are applied and/or incorporated. If one (or more) learning processes are missing, the effectiveness and comprehension of learning will deteriorate. The following illustration gives an overview of the categories describing distinctive approaches to learning.[11]

Orientation and intention	Motivation	Approach or style	Process Stage 1	Process Stage 2	Outcomes
Understanding	Intrinsic (Autonomous and syllabus-free)	Deep approach/ versatile	All 4 processes below used appropriately to reach understanding		Deep level of understanding
		Comprehension learning	Process A	Process B	Incomplete understanding attributable to globe-trotting
Reproducing	Extrinsic and fear of failure (Anxious and syllabus-bound)	Operation learning	Process C	Process D	Incomplete understanding attributable to improvidence
		Surface approach	Memorisation	Overlearning	Surface level of understanding
Achieving high grades	Hope for success (Stable, self-confident, and ruthless)	Organised and/or achievement oriented	Any combination of the six above processes considered appropriate to perceived task requirements and criteria of assessment		High grades with or without understanding

Explanation of learning processes:
A: Building overall description of content area.
B: Reorganizing incoming information to relate to previous knowledge or experience and establishing personal meaning.
C: Detailed attention to evidence and steps in the argument.
D: Relating evidence to conclusion and maintaining a critical, objective stance.

This illustration represents Entwistle's attempt at bringing together the work of Marton, Pask and Biggs within a framework

[11] A German version of this overview may be found in: R. Dubs, 1985, p. 132

provided partly by a factor analysis of the Lancaster inventory and partly by the earlier conceptual analyses. The Lancaster Inventory is based on previous work by Entwistle et al. (with the scales organized study methods, achievement motivation, fear of failure, disillusioned attitudes, syllabus boundness, and sociability). To these were added the Marton and Pask dimensions of deep level and surface level approach, comprehension and operation learning. Other dimensions were based on the interviews by Ramsden and on items used by Biggs as the strategic approach, intrinsic and extrinsic motivation. The inventory was developed through series of pilot versions. As a result of item analyses, three scales were dropped (internality, openness and sociability). As a matter of fact, the inventory encompasses 12 scales; each of it is characterized by 6 items.

To conclude, the authors state that the main advance provided by this illustration is to isolate four distinct processes of learning, all of which are essential to a deep level of understanding. This model may be a good starting-point and interesting framework for instructors to evaluate inappropriate learning behaviors of students.

2.3. Hunt's conceptual levels[12]

Conceptual level (CL), a motivational instrument, was developed by David Hunt. It describes the degree of structure a person needs to learn effectively. Hunt distinguishes three conceptual levels. Students with a low CL (= level A) need high structure; they are impulsive, concrete and have a low frustration tolerance level. Students with a medium CL (= level B) need quite some control and structure; they think in categories and believe in authorities. Finally, students with a high CL (= level C) need less structure; they are independent, self-employed, are looking for alternatives.

As a matter of fact, there may be very intelligent students with a low CL (level A). On the other hand, students less intelligent with medium or high CL (level B or C) rarely will be found. Students typically develop through unsocialized, dependent, and independent stages, requiring successively less structure and increasing self-expression and autonomy.

Hunt designed an inventory for students to identify his/her conceptual level. It is possible to derive the student's conceptual level from a short written essay/statement given a specified subject.

Finally, Hunt established a list of guidelines for instructors to adapt teaching according to the three conceptual levels (A = unskillful, B = dependent, and C = independent).

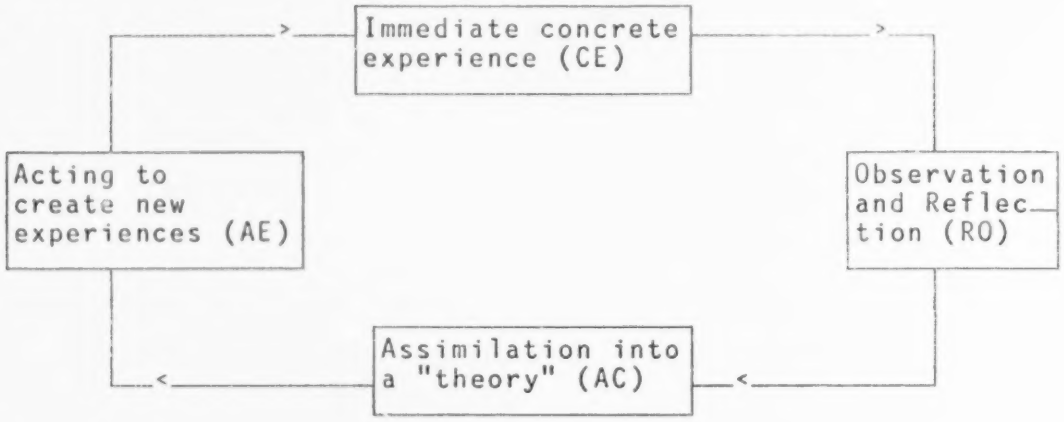
2.4. Kolb's learning style inventory[13]

Kolb's LSI is a simple self-report test, based on experiential

[12] See: R. Dubs, 1985, pp. 124 - 126

[13] See: D.A. Kolb, Learning Style Inventory, Self-Scoring Test and Interpretation Booklet, Boston (MA), 1976

learning theory. Experiential learning is conceived as a four stage cycle:


Immediate concrete experience (CE)
Observation and Reflection (RO)
Assimilation into a "theory" (AC)
Acting to create new experiences (AE)

The effective learner relies on four different learning modes:
- Concrete Experience (CE),
- Reflective Observation (RO),
- Abstract Conceptualization AC), and
- Active Experimentation (AE).

Kolb designed an inventory consisting of nine sets of four words that are rank ordered by the subject. Two bipolar dimensions are assessed: **Concrete** Experience (CE) **versus Abstract** Conceptualization (AC) and **Active** Experimentation (AE) **versus Reflective** Observation (RO). A learning style profile is obtained with scores for each measure. A student then can calculate a single point (as a combination of the four basic learning styles) and mark the resulting point in the "Learning Style Type Grid". Moreover, Kolb developed "norms for the LSI" being established on a data base of 1,993 persons.

The instrument was developed for use with college students but is currently being used with high school and junior high students, too.[14]

2.5. Preference scales for students

Another group of assessment instruments focuses on the concept of preference scales for students. One of these is the Grasha-Riechmann Student Learning Style Scales (SLSS); another one is Owens and Straton's Learning Preference Scale - Students (LPSS).

The **Grasha-Riechmann SLSS (Student Learning Style Scales)**[15] is a 90-item self-report scale that is group administered. The five-point Likert-type scale assesses the following six learning styles conceptualized by Grasha:

- Independent,
- Avoidant,
- Collaborative,
- Dependent,

[14] B.G. Ferrell, 1983, p. 34
[15] B.G. Ferrell, 1983, p. 34

- Competitive, and
- Participant.

Each style is assigned a score. This instrument was developed for use with four-year college students and has been used with them, with graduate students, with two-year college students, and with high school students.

The Owens-Straton LPSS (Learning Preference Style for Students)[16] is a 42 item self-report scale. Each of the 42 items includes a brief statement about a feature of the three possible learning modes or goal structures conceptualized by Johnson and Johnson based on the work of Deutsch[17]:

- **Co-operative** goal structure (exists when students can achieve their own goals only by working together with others);
- **Competitive** goal structure (exists when students can achieve their own goals only when others fail to achieve their goals); and
- **Individualistic** goal structure (exists when students can achieve their own goals no matter what others have chosen to do).

The development of the LPSS is based on other instruments[18] but tried to overcome their weaknesses. After pilot testing, the main testing was administered with 1643 students (one state high school and a neighboring primary school). The authors state that instructors have a means of discovering the learning preferences of the students in the class. However, they continue, it would be desirable, using the results of this main study, to develop a shortened version of the instrument that might be applied in schools more easily.

2.6. Summary

The following synopsis gives an overview of the main characteristics of all the instruments and models above-mentioned comparing the assessed learning styles, the types of behaviors included in the instrument, and the form of the instrument.

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[16] L. Owens, and R.G. Straton, The Development of a Co-operative, Competitive, and Individualised Learning Preference Scale for Students, in: British Journal of Educational Psychology, Vol. 50 (1980), pp. 147 - 161

[17] D.W. Johnson, and R.T. Johnson, Learning Together and Alone: Co-operation, Competition, and Individualization, Englewood Cliffs, 1975, p. 7, in: L. Owens, and R.G. Straton, 1980, pp. 147 - 148

[18] Such as the Minnesota School Affect Assessment (MSAA) and the Social Interdependence Scales.

Comparison of learning style inventories (LSI)

Model (Author(s))	Learning styles assessed	Types of behaviors	Form
Dunn LSI (Dunn, Dunn, & Price)	Individual style for each person	Physiological, affective	104 item self-report
Model of learning behavior (Entwistle)	Deep approach Comprehension learning Operation learning Surface approach Organized/achievement oriented	Cognitive	(Lancaster inventory)
Model of conceptual levels (Hunt)	Unskillful (level A) Dependent (level B) Independent (level C)	Affective/ Motivational	self-report as a statement/ essay
Kolb LSI (Kolb)	Converger Diverger Assimilator Accomodator	Cognitive	9 sets of four words self-report rank order
SLSS preference Scale (Grasha and Riechmann)	Independent Avoidant Collaborative Dependent Competitive Participant	Affective	90 item assessment scale (self-report)
LPSS preference Scale (Owens and Straton)	Co-operative Competitive Individualized	Affective	42 item assessment scale

3. Discussion

Limitations of models and instruments

A selection of models and instruments to identify a student's learning style has been outlined. All these instruments and models underlie the same assumptions - as explained in the introductory section - and some basic limitations as follows:[17]

1) The main weakness of these psychometric instruments and/or models is the restriction of the analysis to the set of statements contained in the inventory. This constrains the student to describe his approach within the given framework of ideas provided by the inventory.
2) Moreover, the result thus derived may be seen as being excessively static; it is difficult to express the tentative,

[17] See: N. Entwistle, D. Hounsell, Student Learning in its Natural Settings (Editorial), in: Higher Education, Vol. 8 (1979), No. 1 (January), pp. 359 - 363

trial-and-error nature of much (student) learning through a set of inventory scores.

3) Finally, there is an assumption of stability and consistency of behavior. The model and/or instrument and its result is viewed as a function of the individual, rather than a reaction to a situation.

To conclude, all these models and inventories cannot faithfully describe the totality of a student's experience. On the other hand, this research technique (i.e. the psychometric approach) retains the advantage of providing quantitative estimates of the relative strengths of relationships between different aspects of studying.

Strengths and shortcomings

Besides these limitations, the models and instruments have the following strengths and shortcomings:

Approach(es)	Strength	Shortcomings
Dunn LSI:	Encompasses two behaviors (physiological and affective).	Each person has its individual style; may be more idiosyncratic than practical Ferrell found that this inventory did not measure what it intends to.[20] 104-item true-false instrument; takes time! Originally designed for elementary school children. Lacks a clearly defined cognitive domain.
Entwistle:	Introduces a holistic view of the problem; is a sort of checklist and framework for instructors to detect inappropriate learning behaviors of students.	The model is based on an assessment instrument. However, the administration of this instrument seems to be quite time-consuming; the inventory encompasses 72 items!
Hunt:	This concept introduces the importance of structuring the learning task and adapting teaching to these conceptual levels.	The students writes a free form essay/statement based on a given subject; may be difficult for interpretation. Focuses on the affective domain only.

Comparison of learning style inventories (LSI)

Kolb LSI:	Simple and short self-report description test (ranking nine sets of four words). After Ferrell, Kolb's LSI is the only inventory that measures what it intends to measure.[21] Kolb provides results of a **normative** group to compare.	Focuses on the cognitive behavior only. Originally designed in and for the college environment.
Preference Scales	Introduced new aspects in the discussion of learning styles. LPSS originally designed for primary and high school students; tested on a large sample	SLSS originally designed in and for the college environment. Takes time! (SLSS = 90 items, LPSS = 42 items) Results of assessments show that it is difficult to identify individual preferences.[22]

Methodological problems[23]

A potential experimenter (instructor and/or researcher) of such a model and/or instrument is confronted with the fact that the inventories are **not** designed for the same thing exactly and/or the same group of students; **there are many categorizations of learning styles.** Obviously, all inventories do **not** seem to measure the **same** things and **no one** instrument encompasses all **three** types of behaviors defined by Keefe (physiological, affective and cognitive). Finally, the inventories try to measure a student's **stable** learning behavior but it is not obvious if he/she will behave in a learning situation the way he/she reported in the LSI.

Selection of an instrument for the planned empiric study

Faced with existing measures of student learning styles, it has become obvious that all instruments have weaknesses, but it is not our purpose to design new instruments for the purpose at hand (because this is not our primary focus within this study). Taking in consideration all these limitations, methodological problems, strengths and shortcomings of existing instruments, Kolb's learning style inventory (LSI) seems to be an appropriate solution for the purpose at hand for the following reasons:

1) Kolb **tested** his instrument on **large samples**; the normative group encompasses 1,993 persons with diverse backgrounds!

[20] B.G. Ferrell, 1983, p. 36
[21] B.G. Ferrell, 1983, p. 36
[22] R. Dubs, 1985, p. 131
[23] For further details see: A. Brew, B. McCormick, Student Learning and an Independent Study Course, in: Higher Education, Vol. 8 (1979), No. 1 (January), pp. 429 - 441

2) The instrument is **quite simple**; the students just have to rank order nine sets of four words. This removes the danger of **overloading** students with too many demands within a fairly **short period** of time.

3) In a factor-analytic comparison of four learning style inventories (DMI[24], Dunn, Kolb, and SLSS) with a sample of 471 students enrolled in four **high schools** and three community colleges in southern Illinois (USA), **only** Kolb's LSI supported his conceptualization of learning style(s)! This let us suppose that Kolb's LSI seems to be a **valid** instrument that may be applied with **high** school students, too.[25]

   In Switzerland, Kolb's LSI - and all other instruments mentioned above - are not in everyday use at schools. For the time being, we only know from one long term assessment and application of Kolb's LSI.[26] Moreover, the results of this Swiss experience seem to support Kolb's conceptualization, too.[27]

   Analyses of other researchers[28] focusing on the EFT (= Embedded Figures Test) and the RFT (= Road-and-Frame Test) show high reliability measures for Witkin's EFT[29], too. The EFT, a perceptual test, assesses the extent to which the organization of the prevailing field dominates perception of any of its parts. The **field-dependent** learner follows the organization of the field as presented, whereas the relatively field-independent person is able to overcome the organization of the field; i.e. to break it up in order to locate a sought-after component.

4) Finally, it is our concern here to assess the relationship between the learning outcomes and a learning task dependent on student characteristics, as the learning style. In this sense, Kolb's LSI is a well established and common instrument to identify **quantitatively** the students' **cognitive** learning styles (as entry behavior) which we take as a predisposition of a student studying and/or learning in a given situation (= test treatment with courseware materials).

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[24] DMI = Johnson Decision Making Inventory

[25] B.G. Ferrell, 1983, p. 36

[26] Prof. Hochuli at the Neu-Technikum in Buchs is applying the German translation of Kolb's LSI for about three years. He works with this instrument to show his students their learning style.

[27] Out of 185 students at the Neu-Technikum, about 33 % are Convergers, 29 % Assimilators, 19 % Divergers, 3 % Accomodators. The remaining percentage is made up of students that fall onto the borders between the four quadrants and/or the point of intersection (16 %).

[28] For further details see: H.-P. Musahl, Untersuchungen zum Konzept der sog. Feldabhängigkeit (Witkin): Eine experimentelle Grundlagenstudie, Forschungsbericht Nr. 2553 Fachgruppe Wirtschafts- und Sozialwissenschaften, Opladen, 1976, p. 19

[29] For further details see: H.A. Witkin, et al., A Manual for the Embedded Figures Test, Palo Alto (CA), 1971

Interestingly enough, these reflections and reasons above-mentioned are **consistent** with Kolb's own design goals for his learning style inventory (LSI)[30]:
- Kolb tried to construct the LSI in such a way that people would respond to it in somewhat the **same way** as they would a learning situation.
- The LSI was constructed with the hope that it would prove to be **valid** - that the measures of learning styles would predict behavior in a way that was consistent with experiential learning.
- The instrument should be **brief** and **straightforward.**

Summary
Various instruments and models exist to identify a student's learning style. All are based upon assumptions, have limitations due to the research approach, but have immanent strengths, too. Moreover, a potential experimenter (instructor and/or researcher) of such an instrument has to be aware of some immanent methodological problems.

Faced with existing measures of student learning styles, it has become apparent that all instruments have weaknesses. Taking in account these investigations, Kolb's learning style inventory (LSI) has been selected to be an appropriate solution for the purpose at hand for various reasons above mentioned.

4. Application and interpretation of Kolb's LSI[31]

Kolb's learning style inventory (LSI) will be part of a battery of tests within a pretest-posttest experimental design with control groups.

What does Kolb's LSI measure - Statement of hypotheses

The LSI **measures** the relative **emphasis of the four learning modes** by asking the student to rank order nine sets of four word-items that describe these different abilities.
Now, we **hypothesize** that students with distinctive learning styles (i.e. distinctive emphasis of the bipolar learning modes) will react differently to the same courseware material. Moreover the same student will discriminate between materials with a distinctive implementation of courseware characteristics (such as instructional factors, differing in subjects and courseware strategy), but representing a fair quality of production.

Description of the four learning modes

A **high score on Concrete Experience (CE)** represents a receptive, experience-based approach towards learning that heavily relies on feeling-based judgements. High CE individuals tend to be empathetic and "people-oriented". They generally find theoretical approaches to be unhelpful; they prefer to treat each situation as a unique case.
They learn best from specific examples in which they can become involved. Individuals who emphasize CE tend to be oriented more towards peers and less toward authority in their approach to learning; they profit most from feedback and discussion with fel-

[30] D.A. Kolb, 1984, pp. 66 -68
[31] See: D.A. Kolb, 1976, p. 5 and 7

low CE learners.

A high score on Abstract Conceptualization (AC) indicates an analytical, conceptual approach to learning that heavily relies on logical thinking and rational evaluation. These individuals tend to be oriented more towards things and symbols and less towards other people.
They learn best in authority-directed, impersonal learning situations that emphasize theory and systematic analysis. They are frustrated by and profit little from unstructured "discovery" learning approaches like exercises and simulations.

A high score on Active Experimentation (AE) represents an active, "doing" orientation to learning that heavily relies on experimentation.
High AE individuals learn best when they can engage in such things as projects, homework, or small group discussions. They dislike passive learning situations such as lectures. These individuals tend to be extroverts.

A high score on Reflective Observation (RO) indicates a tentative, impartial and reflective approach to learning. These individuals heavily rely on careful observation in making judgements, and prefer learning situations such as lectures that allow them to take the role of impartial objective observers. These individuals tend to be introverts.

The two combination scores, AC - CE and AE - RO, give a single data point that combines the scores on the four basic modes. The resulting data point can be marked within the learning style type grid with the four quadrants, labelled **Accomodator**, **Diverger**, **Converger**, and **Assimilator**. The closer the resulting point is to the point where the lines cross the more balanced is the learning style. If the resulting data point is close to any of the four corners, this indicates that the individual heavily relies on one particular learning style!

Description of the four learning styles
The four learning styles may be described as follows:

- Converger: His dominant learning abilities are Abstract Conceptualization (AC) and Active Experimentation (AE). This person's greatest strength lies in the practical application of ideas. A person with this style seems to perform best in those situations like conventional intelligence tests where there is a single correct answer or solution to a question or problem. This person's knowledge is organized in such a way that through hypothetical-deductive reasoning this individual can focus it on specific problems. Research on this style of learning shows that Convergers are relatively unemotional, preferring to deal with things rather than people. They tend to have narrow technical interests, and choose to specialize in the physical sciences. This learning style is characteristic of many engineers.

- Diverger: This individual has the opposite learning strengths of the Converger. He/she is best at Concrete Experience (CE) and Reflective Observation (RO). This person's greatest strength lies in imaginative ability. This person excels in the ability to view concrete situations from many perspectives.

Kolb has labelled this style "Diverger" because a person with this style performs better in situations that call for generation of ideas such as a "brainstorming" idea session. Research shows that Divergers are interested in people and tend to be imaginative and emotional. They have broad cultural interests and tend to specialize in the arts. This style is characteristic of individuals from humanities and liberal arts backgrounds. Counselors, organization development specialists and personnel managers tend to be characterized by this learning style.

- Assimilator: His/her dominant learning abilities are Abstract Conceptualization (AC) and Reflective Observation (RO). This person's greatest strength lies in the ability to create theoretical models. This person excels in inductive reasoning and in assimilating disparate observations into an integrated explanation. This person, like the Converger, is less interested in people and more concerned with abstract concepts, but is less concerned with the practical use of theories. For this person it is more important that the theory be logically sound and precise; in a situation where a theory or plan does not fit the "facts", the Assimilator would be likely to disregard or re-examine the facts. As a result, this learning style is more characteristic of the basic sciences and mathematics rather than in applied sciences. In organizations this learning style is found most often in the research and planning departments.

- Accomodator: This person has the opposite learning strengths to the Assimilator. He/she is best at Concrete Experience (CE) and Active Experimentation (AE). This person's greatest strength lies in doing things - in carrying out plans and experiments - and involving oneself in new experiences. This person tends to be more of a risk-taker than people with the other three learning styles. Kolb has labelled this person "Accomodator" because this person tends to excel in those situations where one must adapt oneself to specific immediate circumstances. In situations where a theory or plan does not fit the "facts", this person will most likely discard the plan or theory. This person tends to solve problems in an intuitive trial and error manner, relying heavily on other people or information rather than on one's own analytic ability. The Accomodator is at ease with people but is sometimes seen as impatient and "pushy". This person's educational background is often in technical or practical fields such as business. In organizations people with this learning style are found in "action-oriented" jobs, often in marketing or sales.

Application of inventory versions for the empiric test

An English and a German version of Kolb's Learning Style Inventory (LSI) are prepared for the empiric test:

- The English one is a copy of the original version outlined in D.A. Kolb's Learning Style Inventory, Self-Scoring Test and Interpretation Booklet"[32];

[32] More detailed information may be found in: D.A. Kolb, The Learning Style Inventory: Technical Manual, Boston (MA) [Mc Ber and Company], 1976 [Kolb, 1976a]

- The German one is a translation of the original version established by R. Dubs[33]
  At the time of publication, the Germar version has not been strongly validated. But Dubs reported that first evaluations of the German version of the instrument in Swiss "Mittelschulen" generated results comparable to the U.S. validation![34]

5. Summary and conclusions

Impacts of courseware characteristics on variation(s) of learning effectiveness due to learner characteristics shall be put forward for examination in an empiric study. This paper focused on learner characteristics, especially the (cognitive) learning styles. It offered an overview of selected instruments and models to describe and identify such styles, such as the Dunn LSI, Entwistle's styles of learning, Hunt's conceptual levels, Kolb's LSI, and the concept of preference scales. Underlying assumptions, strengths and shortcomings, and limitations of available instruments were outlined. It has been shown that a potential experimenter who wishes to assess (cognitive) learning styles should be aware of the shortcomings of the instrumentation.

Taking in account all these shortcomings on the one hand and the research question to investigate on the other hand, Kolb's Learning Style Inventory (LSI) has been selected for the purpose at hand.

Two language version of Kolb's LSI are prepared: Kolb's instrument - an English version - and a German translation. For the time being, the German version of the instrument generated results comparable to the U.S. validation.

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[33] R. Dubs, 1985, pp. 315 -318
[34] Hochuli's results seem to confirm this statement.

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[35] NASS = National Association of the Secondary School